Organic on-farm research to explore the impact of diversity on winter wheat

Antoine Marin, Véronique Chable

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SAFARI, Agro-diversités génétique et spécifique pour la Santé des plantes, la Fertilité des sols, l'Adaptation et la Résilience des systèmes de culture (2013-2017)
ReMIX, The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 727217 (2017-2021)

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The SAFARI Project overview

Studying and Managing Diversity for:

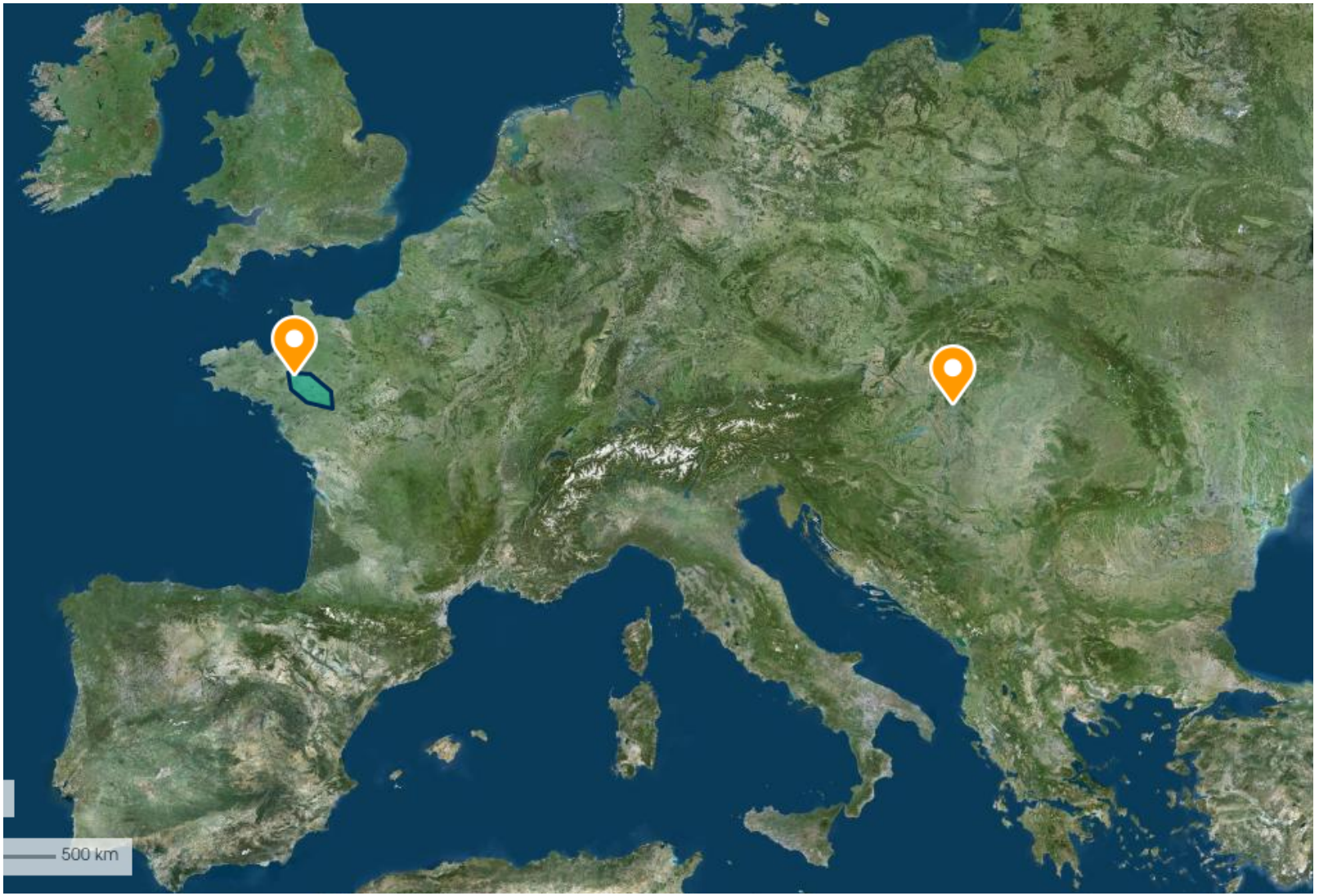
- Protein production (legumes)
- Plant health
- Grain quality (protein content)
- Crop stability

Thanks to:

Farmers : André Despinasse, Michel Kervarec, Laurent Marteau, Florent Mercier, Gilles Simmoneaux, Pierre Tranchant – **Technicians** : Sylvie Nègre, Benoit Robert, Yannick Autret, Stéphane Texier – **Trainees** : Gildas Baron, Meven Cabon, Camille Deniveau, Ghislain Ghourbi, Antoine Muniglia, Pierre Patureau, Christophe Rousseau – **Other scientists** : Paul De la Grandville, Simon Rousselot, Estelle Serpolay

Experimental Design
Where and When?

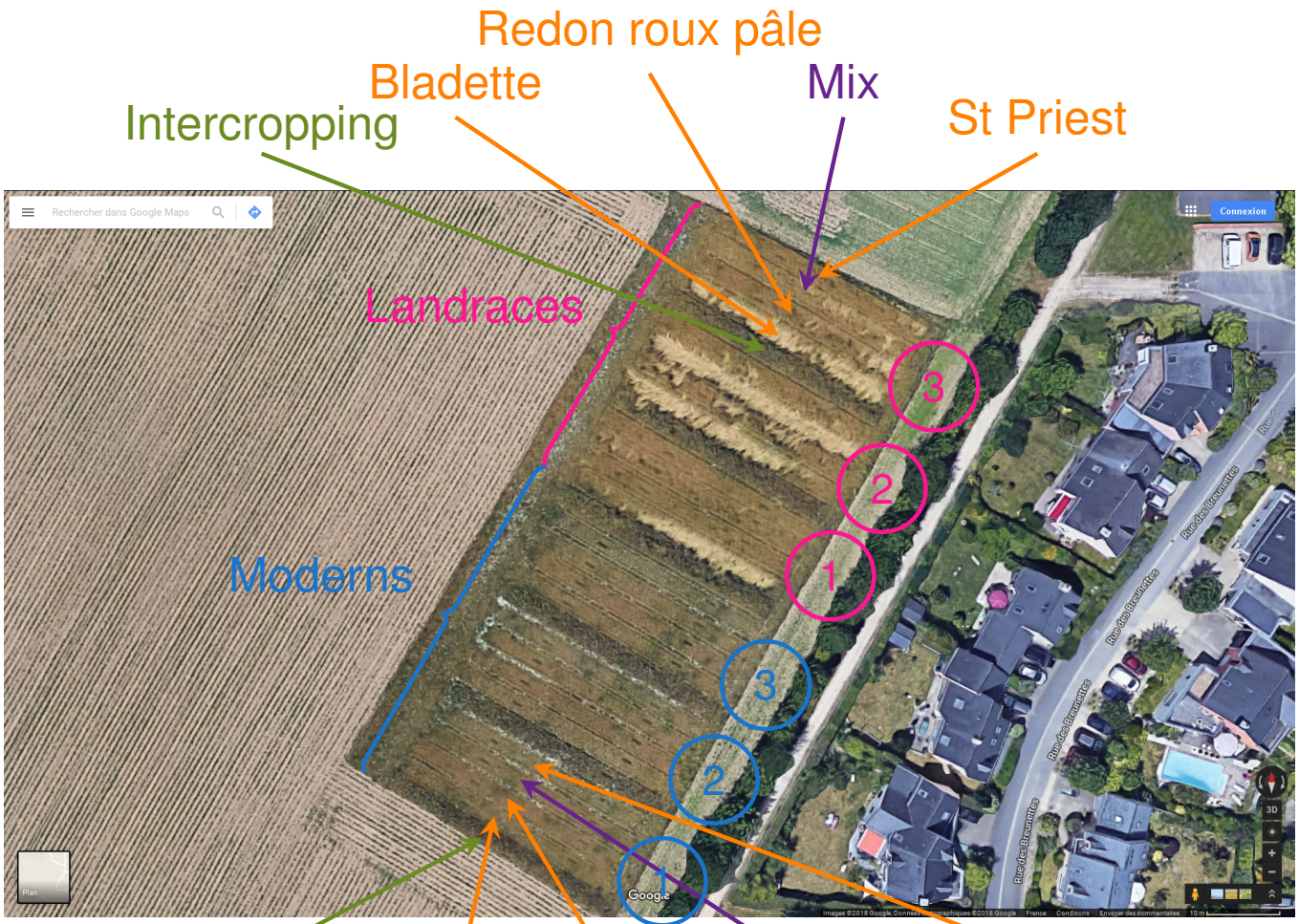
In France, 5 locations in and around Brittany from 2014 to 2017



Experimental Design
How? [1/2]

2 types × 5 modalities × 3 repetitions

In each farm



Experimental Design
How? [2/2]

On farms

- Organic agriculture 4/5 farms
- No inputs before and during the culture
- The crop is reseeded each year
- Ploughing
- Seedling dates around November
- Seedling rates between 300 and 400 sd./m^2

Statistics

- R software
- Simple linear models
- Levene's test for the equality of variances
- Tukey's HSD test for multiple comparison

Experimental Design
What?

Modern varieties

- Chevalier (au, 2006)
- Renan (fr, 1990)
- Pireneo (au, 2004)

Landrace varieties

- Bladette de Provence
- Redon Roux Pâle
- Saint Priest et le Vernoix rouge

Legumes

- Fababean (Diva [fr, 2001])
- Clovers

Observed parameters

Plants

- **Mycorrhiza** (roots)
- Covers (including wilds)
- Heights
- **Diseases** (leaves)
- **Biomasses**
- **Lodging**
- ...

Spikes

- Colour
- Number of spikelets / spike
- Number of seeds / spike
- Awn
- Spike length
- Number of sterile spikes
- ...

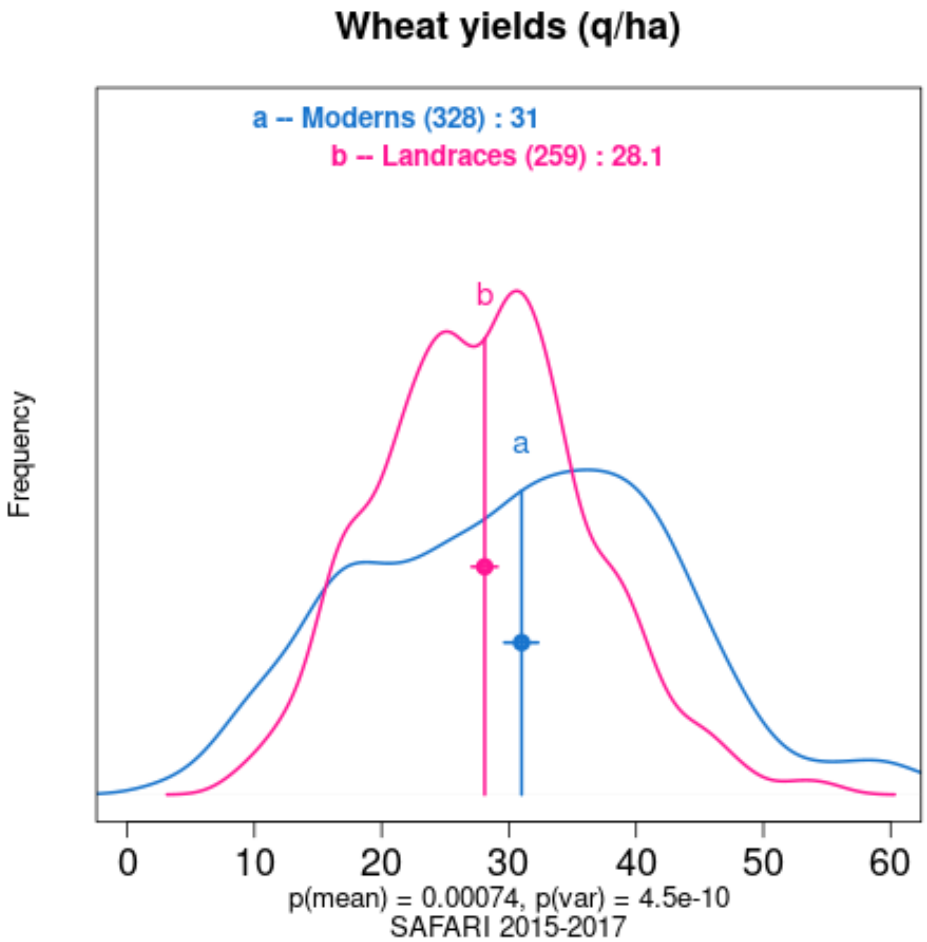
Soil

- Micro-organisms (collaboration)
- Soil tests

Yield components

- **Grain yields**
- Straw yields
- Number of spikes / m^2
- Number of seeds
- Thousand Kernel Weight
- **Grain Protein Content**
- ...

How we interpret results?



"Pierre Dragicevic, 2015, HCI Statistics without p-values"

Main results

What is already known

- an overall wheat **grain yield** around 3 t/ha (like the French national mean in OA)
- the intercropping (overseeded) wheat with legumes decreases wheat **grain yield** from 25%
- the overall wheat **grain protein content** is around 13% (around 11.5% in France, probably more in OA?)
- intercropping wheat with legumes increases wheat **grain protein content** from 12.5 to 13.5%
- wheat **lodging** was 40% for landraces while around 1% for modern varieties

Main results

New insights [1/2]

- Wheat landraces **yields** are **more stable** over sites and years
  - → Ability to adapt various and changing growing conditions
- Wheat landraces show **less competition** with legumes (less yield decrease) than modern varieties
  - → Ability for intercropping
- The **total dry matter** yields including straws and legumes reached 11.4 t/ha for landrace and only 9.3 t/ha for modern varieties
  - → Interest for carbon production / fixation, soil improvement, etc.

Main results

New insights [2/2]

- The **grain protein content** of landraces was 13.3% whilst it was only 12.1% for modern varieties
  - → Interesting as source of proteins
- **Plant health** was better for landrace varieties than for modern varieties
  - → Interest for organic / no inputs agriculture
- **Arbuscular mycorrhiza** fungi wheat root colonization was 6% higher for landrace varieties than for modern ones (in ploughing conditions)
  - → Better use of soil nutrients

What next in ReMIX?
co-evolution

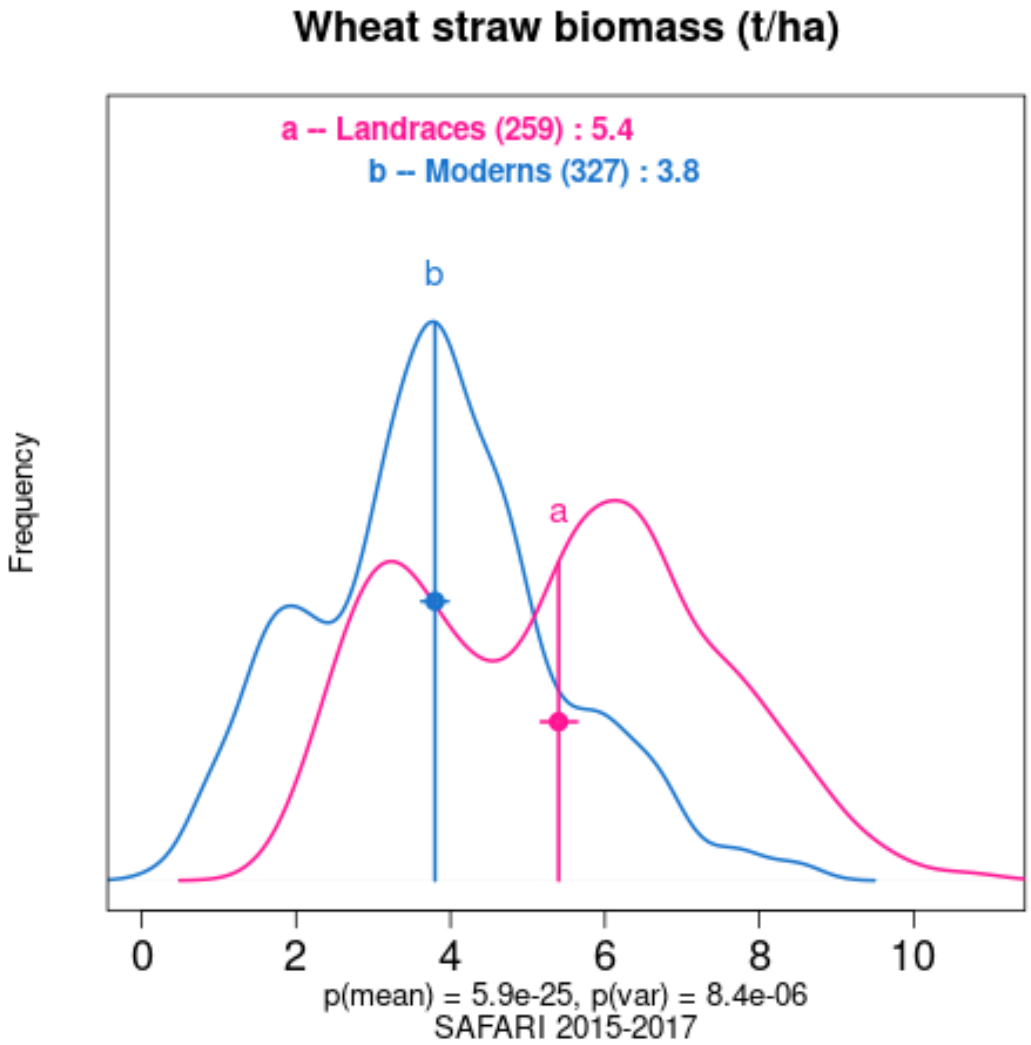
Question

Is there a co-evolution between the wheat and the fababean?

After 6 years of co-evolution, re-sowing seeds year after year

- Cultivate separately wheat and fababean that have grown together
- Cultivate together wheat and fababean that have grown separately

Straw yields
Modern and Landrace



Straw yields

Building a straw bale house with spelt